Programme Specification for the [MSc in Bioinformatics and Theoretical Systems Biology]

PLEASE NOTE. This specification provides a concise summary of the main features of the programme and the learning outcomes that a typical student might reasonably be expected to achieve and demonstrate if he/she takes full advantage of the learning opportunities that are provided. This specification provides a source of information for students and prospective students seeking an understanding of the nature of the programme and may be used by the College for review purposes and sent to external examiners. More detailed information on the learning outcomes, content and teaching, learning and assessment methods of each module can be found in the course handbook or on-line at http://www3.imperial.ac.uk/pgprospectus/facultiesanddepartments/lifesciences/postgraduatecourses/bioinformatics]. The accuracy of the information contained in this document is reviewed by the College and may be checked by the Quality Assurance Agency.

1. Awarding Institution: Imperial College London
2. Teaching Institution: Imperial College London
3. External Accreditation by Professional / Statutory Body: Not applicable
4. Name of Final Award (BEng / BSc / MEng etc): MSc
5. Programme Title (e.g. Biochemistry with Management): Bioinformatics and Theoretical Systems Biology
6. Name of Department / Division: Lifesciences
7. Name of Faculty: Natural Sciences
8. UCAS Code (or other coding system if relevant): Not applicable
9. Relevant QAA Subject Benchmarking Group(s) and/or other external/internal reference points
   Not Applicable
10. Level(s) of programme within the Framework for Higher Education Qualifications (FHEQ):

<table>
<thead>
<tr>
<th>Level(s) of programme</th>
<th>Level</th>
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<tbody>
<tr>
<td>Bachelor’s (BSc, BEng, MBBS)</td>
<td>Level 6</td>
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<tr>
<td>Integrated Master’s (MSci, MEng)</td>
<td>Levels 6 and 7</td>
</tr>
<tr>
<td>Master’s (MSc, MRes)</td>
<td>Level 7</td>
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11. Mode of Study
    Full Time

12. Language of Study: English

13. Date of production / revision of this programme specification (month/year):
    October 2009

14. Educational aims/objectives of the programme
1   [MSc in Bioinformatics and Theoretical Systems Biology]
The programme aims/objectives are to:

- produce graduates equipped to pursue careers in bioinformatics and systems biology in industry, the public sector and non-governmental organisations;
- develop understanding of bioinformatics and systems biology underpinned by a combination of programming and mathematical skills together with an awareness of current biological issues;
- develop understanding of tools and methods of modern bioinformatics and systems biology and their application;
- develop broad research and analytical skills related research in bioinformatics and systems biology;
- attract highly motivated students, from the UK and overseas;
- to appreciate the ethical implications of bioinformatics and systems biology;
- develop new areas of teaching in response to the advance of scholarship and the needs of vocational training.

15. Programme Learning Outcomes

1. Knowledge and Understanding

Knowledge and Understanding of

A. Knowledge and understanding of:
   1. Principles of the modern life- and biomedical sciences.
   2. Basic Mathematics and Statistics.
   3. Programming in Python, Perl and JAVA;
   4. Analysis of DNA, Protein, biological diversity and molecular interaction data.
   5. Use of bioinformatics and systems biology data bases.
   6. Detailed knowledge and understanding of algorithms in bioinformatics and theoretical systems biology.
   7. Understanding of principles and practice of software development.
   8. Research techniques, including information and data retrieval, study design, program development and implementation, data analysis and statistics, and mathematical modelling;
   9. Management and communication skills, including problem definition, project design, decision processes, teamwork, written and oral reports, scientific publications.

Teaching/learning methods and strategies

Acquisition of A1 to A6 is through a combination of lectures, computer-based work and coursework.

Acquisition of A7-A9 is through a 12 week group project, which involves the development of a major piece of software under the guidance of a member of the Department of Computing (March to May), a 10-12 week project in data analysis and a 12 week research project in bioinformatics (June to August).

Throughout the students are encouraged to undertake independent reading both to supplement and consolidate what is being taught/learnt and to broaden their individual knowledge and understanding of the subject.

Assessment of knowledge is through unseen written examinations (A1-A6), assessed coursework (A2-A5), assessed group reports and presentation (A8, A9), individual project reports (A7-A9), development of a web-page (A4-A9) and a viva (A8, A9).

2. Skills and other Attributes

B. Intellectual Skills

2 [MSc in Bioinformatics and Theoretical Systems Biology]
1. Understand and evaluate current research through reading published papers in recommended journals
2. Decide appropriate scientific methods and techniques for analysing raw data and solving phylogenetic problems.
3. Develop and implement strategies for modelling biological systems
4. Plan, undertake and write up an original and individual research project

**Teaching/learning methods and strategies**

During the research projects students are exposed to and can discuss ongoing research and published work with their academic and their research groups.

Bioinformatics and systems biology research design and mathematical/statistical skills are developed in lectures and computer-based practical work in the taught part of the course, and subsequently in the two research projects.

Assessment is through coursework, oral presentations, written examinations and the research projects.

**C. Practical Skills**

1. Use bioinformatics and systems biology tools and databases to collect, model and analyze data;
2. Plan, develop, implement, and document bioinformatics and modelling software.
3. Plan and execute an individual research project in bioinformatics/systems biology;
4. Prepare technical reports;
5. Prepare reports for an intelligent lay audience;
6. Give technical presentations;
7. Use the scientific literature effectively;
8. Use computational tools and packages.

**Teaching/learning methods and strategies**

Practical skills are developed through the teaching and learning programme outlined above (and in section 11). Practical skills (C1 to C3 and C8) are developed through laboratory, computer-based and project work. Skills C4 and C5 are taught and developed through feedback on reports written and presentations made as part of coursework assignments.

Skill C6 is developed through lectures, coursework reports and essays, group project exercises and the individual supervised research project.

Skill C7 is taught and developed through coursework exercises and project work.

Practical skills are assessed through laboratory experiment write-ups, coursework reports and the research project dissertation.

**D. Transferable Skills**

communicate effectively through oral presentations, computer processing and presentations, written reports and scientific publications (B);
apply statistical and modelling skills;
management skills: decision processes, objective criteria, problem definition, project design and evaluation, risk management, teamwork and coordination, extension needs (B);
integrate and evaluate information from a variety of sources (B);
transfer techniques and solutions from one discipline to another;
use Information and Communications Technology (B);
manage resources and time (B);
learn independently with open-mindedness and critical enquiry (B);
learn effectively for the purpose of continuing professional development (B).
Teaching/learning methods and strategies

Transferable skills are developed through the teaching and learning programme outlined above. Skill D1 is taught through coursework and developed through feedback on reports and oral presentations. Skill D2 is taught through lectures and practical work and developed, as appropriate, during the individual research project. Skills D3 to D5 are developed through project work. Skill D6 is developed through computer-based exercises, projects and other coursework activities and individual learning. Skill D7 is developed throughout the course within a framework of staged coursework deadlines and the split examination system. Although not explicitly taught, skills D8 and D9 are encouraged and developed throughout the course, which is structured and delivered in such a way as to promote this.

Skill D1 is assessed through coursework, written examinations and the oral examination. Skill D2 is assessed through coursework, written examinations and project work. Skills D3 to D5 are assessed in workshops. The other skills are not assessed formally.

16. The following reference points were used in creating this programme specification
Course Handbook

17. Programme structure and features, curriculum units (modules), ECTS assignment and award requirements

The programme is only offered as a full-time, one year course and leads to the MSc degree. There are no optional parts of the course. Students carry out coursework for the first term of which four different items are assessed. They then embark on three research projects. The course was awarded 90 ECTS units.

Year One:
Term one:
All students attend an induction week and all students undertake all modules. Bioinformatics and Systems Biology I introduces students to the fundamental concepts of modern biology, including genome projects, the genetic basis of disease, proteomics and the analysis of biological interactions, experimental techniques and mathematical modelling.

The Computing course introduces students to basic software development in Python, Perl and Java.

Bioinformatics and Systems Biology II introduces students to advanced concepts and methods in modern bioinformatics and systems biology, including DNA, protein, diversity and interaction analysis, mathematical modelling of complex biological systems as well as advanced computational tools.

From week 3 onward students are being taught the fundamentals of mathematics, probability theory and statistics necessary to understand modern development in bioinformatics and systems biology.

The computing course is assessed through two assessment in Python, one in Perl and 2 in Java.

Term Two:

4 [MSc in Bioinformatics and Theoretical Systems Biology]
Bioinformatics and Systems Biology I, Bioinformatics and Systems Biology II and Mathematics/Statistics are assessed in written exams.

From January until the start of April students work in groups of 2-4 students on a major software development project. A group and an individual report have to be submitted by the end of the 13 weeks; a group presentation to other students on the course also forms part of the assessment. In rare cases students with extensive software development experience may do an individual research project.

From the start of April students engage in a 10 week data-analysis project in close collaboration with an experimental research group and jointly supervised by a statistical supervisor.

Term Three:
From the beginning of June until the beginning of September students carry out an individual research project in bioinformatics and systems biology (which may be carried out externally).

18. Support provided to students to assist learning (including collaborative students, where appropriate).

- One week induction programme for orientation, introduction to library and information technology, and to bioinformatics;
- MSc Student Handbook and associated material, which includes descriptions of each module.
- Staff:student ratios for teaching of 1:3.
- A large community of postgraduate research students and postdoctoral research workers who work bioinformatics, life sciences and computer science at South Kensington.
- Library and other learning resources and facilities at South Kensington.
- Dedicated computing facilities at South Kensington with 24hr access.
- Open access to staff in Biological Sciences, Computing and Mathematics Departments.
- A dedicated Room for students on this MSc with PC facilities plus private study area.
- An MSc staff - student committee, which meets three times per year.
- Numerous seminar series on Life Sciences and Computing at South Kensington which run throughout the year.
- Students conducting their research projects at an external site are assigned a member of Imperial College academic staff to oversee progress and advise on the project dissertation. Where practical, students will be visited by College staff during their project.
- Student email and open personal access to tutorial staff including the Course Director.
- Access to student counsellors on the South Kensington site.
- Access to Teaching and Learning Support Services, which provide assistance and guidance, e.g. on careers.
- Opportunities for students to conduct their research projects at a wide range of external institutions and companies, including placements overseas.

19. Criteria for admission:

The minimum qualification for admission is normally a Lower Second Class Honours degree in a Science-based subject from an UK academic institution or an equivalent overseas qualification, but in actuality the majority of students have surpassed this minimum. All UK applicants (and where possible overseas applicants) are evaluated by a committee comprising several of the faculty involved with teaching of the MSc. In all other cases a phone interview will be conducted.

20. Processes used to select students:
Shortlisting for interview by the course director together with two other academics. Interview or phone interview with at least 2 members of staff. Either the director or course director attend every interview.

21. Methods for evaluating and improving the quality and standards of teaching and learning

a) Methods for review and evaluation of teaching, learning, assessment, the curriculum and outcome standards:

The external examiner system and Boards of Examiners are central to the process by which the College monitors the reliability and validity of its assessment procedures and academic standards. Boards of Examiners comment on the assessment procedures within the College and may suggest improvements for action by relevant departmental teaching Committees.

The Faculty Studies Committees and the Graduate Schools’ Postgraduate Quality Committees review and consider the reports of external examiners and accrediting bodies and conduct periodic (normally quinquennial) and internal reviews of teaching provision. Regular reviews ensure that there is opportunity to highlight examples of good practice and ensure that recommendations for improvement can be made.

At programme level, the Head of Department/Division has overall responsibility for academic standards and the quality of the educational experience delivered within the department or division.

Most of the College’s undergraduate programmes are accredited by professional engineering and science bodies or by the General Medical Council. Accreditation provides the College with additional assurance that its programmes are of an appropriate standard and relevant to the requirement of industry and the professions. Some postgraduate taught courses are also accredited.

- Module reviews, based on feedback questionnaires and convenor reports.
- Annual course review prepared by the Course Director and considered by the Course Committee and the Imperial College, Departmental Teaching Committee.
- Annual review of the course by an Imperial College academic staff member from outside the department with a report and grading to the Graduate School of Life Sciences and Medicine Education Quality Committee.
- MSc Staff – Student Committee, held each term, with report to Departmental Teaching Committee.
- Biennial staff appraisal.
- Peer teaching observations.
- External Examiner reports.
- Review by BBSRC, MRC and the Wellcome Trust, as part of application process for renewal of Postgraduate Studentships.
- Periodic review of departmental teaching by an external panel with members drawn from another university, a research institute and industry.

b) Committees with responsibility for monitoring and evaluating quality and standards:

The Senate oversees the quality assurance and regulation of degrees offered by the College. It is charged with promoting the academic work of the College, both in teaching and research, and with regulating and supervising the education and discipline of the students of the College. It has responsibility for approval of changes to the Academic Regulations, major changes to degree programmes and approval of new programmes.

The Quality Assurance Advisory Committee (QAAC) is the main forum for discussion of QA policy and the regulation of degree programmes at College level. QAAC develops and advises the Senate on the implementation of codes of practice and procedures relating to quality assurance and audit of quality and arrangements necessary to ensure compliance with national and international standards. QAAC also considers amendments to the Academic Regulations before making recommendations for change to the Senate. It also maintains an overview of the statistics on completion rates, withdrawals, examination irregularities (including cases of plagiarism), student appeals and disciplinaries.
The Faculty Studies Committees and Graduate School Postgraduate Quality Committees are the major vehicle for the quality assurance of undergraduate / postgraduate courses respectively. Their remit includes: setting the standards and framework, and overseeing the processes of quality assurance, for the areas within their remit; monitoring the provision and quality of e-learning; undertaking reviews of new and existing courses; noting minor changes in existing programme curricula approved by Departments; approving new modules, changes in module titles, major changes in examination structure and programme specifications for existing programmes; and reviewing proposals for new programmes, and the discontinuation of existing programmes, and making recommendations to Senate as appropriate.

The Faculty Teaching Committees maintain and develop teaching strategies and promote inter-departmental and inter-faculty teaching activities to enhance the efficiency of teaching within Faculties. They also identify and disseminate examples of good practice in teaching.

Departmental Teaching Committees have responsibility for the approval of minor changes to course curricula and examination structures and approve arrangements for course work. They also consider the details of entrance requirements and determine departmental postgraduate student numbers. The Faculty Studies Committees and the Graduate School Postgraduate Quality Committees receive regular reports from the Departmental Teaching Committees.

- MSc Staff – Student Committee.
- Course Committee.
- Board of Examiners – meets in September to consider awards.
- Departmental Tutors’ Committee.
- Departmental Teaching Committee.
- Graduate School of Life Sciences and Medicine, Educational Quality Committee.
- Imperial College, Graduate Studies Committee.
- Imperial College, Senate

c) Mechanisms for providing prompt feedback to students on their performance in course work and examinations and processes for monitoring that these named processes are effective:

Assignments are handed back and discussed with students. Regular meetings with project supervisors are used to ensure that students are on track. Half-way through the final project the Course director checks up on progress and discusses arising issues with students.

- MSc Staff – Student Committee;
- meetings with personal tutees;
- course questionnaire evaluation of each module;
- viva voca with External Examiner.

d) Mechanisms for gaining student feedback on the quality of teaching and their learning experience and how students are provided with feedback as to actions taken as a result of their comments:

Two anonymous questionnaires are used to collect feedback from students after the taught component and after the three projects, respectively. Furthermore regular (twice-termly) staff-student committee meetings are used to gather and provide feedback.

e) Mechanisms for monitoring the effectiveness of the personal tutoring system:

The course director assigns individual tutors. Tutoring is also assessed as part of the end of course questionnaire.

f) Mechanisms for recognising and rewarding excellence in teaching and in pastoral care:

Staff are encouraged to reflect on their teaching, in order to introduce enhancements and develop innovative teaching methods. Each year College awards are presented to academic staff for
outstanding contributions to teaching, pastoral care or research supervision. A special award for Teaching Innovation, available each year, is presented to a member of staff who has demonstrated an original and innovative approach to teaching. Nominations for these awards come from across the College and students are invited both to nominate staff and to sit on the deciding panels.

g) Staff development priorities for this programme include:
- active research programme in bioinformatics, systems biology and related disciplines;
- staff appraisal scheme and institutional staff development courses;
- college Teaching Development Grant Scheme to fund the development of new teaching and appraisal methods;
- updating professional and IT/computing developments.

22. Regulation of Assessment

a) Assessment Rules and Degree Classification:

The Board of Examiners may award a result of merit where a candidate has achieved an aggregate mark of 60% or greater across the programme as a whole AND has obtained a mark of 60% or greater in each element with the exception of one element AND has obtained a mark of 50% or greater in this latter element.

The Board of Examiners awards a result of distinction where a candidate has achieved an aggregate mark of 70% or greater across the programme as a whole AND has obtained a mark of 70% or greater in each element with the exception of one element AND has obtained a mark of 60% or greater in this latter element.

b) Marking Schemes for undergraduate and postgraduate taught programmes:

The Pass Mark for all postgraduate taught course modules is 50%. Students must pass all elements in order to be awarded a degree.

c) Processes for dealing with mitigating circumstances:

For postgraduate taught programmes: A candidate for a Master's degree who is prevented owing to illness or the death of a near relative or other cause judged sufficient by the Graduate Schools from completing at the normal time the examination or Part of the examination for which he/she has entered may, at the discretion of the Examiners,

(a) Enter the examination in those elements in which he/she was not able to be examined on the next occasion when the examination is held in order to complete the examination,

or

(b) be set a special examination in those elements of the examination missed as soon as possible and/or be permitted to submit any work prescribed (e.g. report) at a date specified by the Board of Examiners concerned. The special examination shall be in the same format as specified in the course regulations for the element(s) missed.

Applications, which must be accompanied by a medical certificate or other statement of the grounds on which the application is made, shall be submitted to the Academic Registrar who will submit them to the Board of Examiners.

d) Processes for determining degree classification for borderline candidates:

Candidates should only be considered for promotion to pass, merit or distinction if their aggregate mark is within 2.5% of the relevant borderline. Nevertheless, candidates whom the Board deems to have exceptional circumstances may be considered for promotion even if their aggregate mark is
more than 2.5% from the borderline. In such cases the necessary extra marks should be credited to bring the candidate’s aggregate mark into the higher range.

e) Role of external examiners:

The primary duty of external examiners is to ensure that the degrees awarded by the College are consistent with that of the national university system. External examiners are also responsible for approval of draft question papers, assessment of examination scripts, projects and coursework (where appropriate) and in some cases will attend \textit{viva voce} and clinical examinations. Although external examiners do not have power of veto their views carry considerable weight and will be treated accordingly. External examiners are required to attend each meeting of the Board of Examiners where recommendations on the results of individual examinations are considered. External examiners are required to write an annual report to the Rector of Imperial College which may include observations on teaching, course structure and course content as well as the examination process as a whole. The College provides feedback to external examiners in response to recommendations made within their reports.

23. Indicators of Quality and Standards

- Favourable comments by External Examiners.
- First destination data for MSc graduates, showing a high proportion find employment or further postgraduate research training in Bioinformatics and related areas.
- Independent review of the quality of the educational provision of the Biochemistry Department by the Quality Assurance Agency subject review process in 1998 achieving an excellent grading of 22 out of a maximum 24 points.

\begin{align*}
\text{Curriculum Design Content and Organisation} & = 4 \\
\text{Teaching Learning and Assessment} & = 3 \\
\text{Student Support and Guidance} & = 4 \\
\text{Student Progression and Achievement} & = 4 \\
\text{Learning Resources} & = 4 \\
\text{Quality Management and Enhancement} & = 3 
\end{align*}

24. Key sources of information about the programme can be found in

Course website:
\url{http://www3.imperial.ac.uk/lifesciences/postgraduate/courselist/bioinformatics}

Graduate school website:
\url{http://www3.imperial.ac.uk/pgprospectus/facultiesanddepartments/lifesciences/postgraduatecourses/bioinformatics}

Course specification:
\url{http://www3.imperial.ac.uk/pls/portallive/docs/1/55458.PDF}